

Material and structural response to dynamic actions in fire

The proposed research is aimed to resolve the influence of fire-induced dynamic actions on structure. In other words, this research will bring us closer to understanding of collapse mechanism of buildings in fire, when fire induces such events as falling of structural elements, impact, explosion. Achieving this goal requires acquiring the knowledge about the behavior of materials at simultaneous high temperature and high deformation rates. This must be achieved experimentally. In this research, the material of interest is structural steel used in civil engineering. The general conclusion on the state of the art is that steel properties at high temperatures simultaneously and high strain rates are not well-recognized research topics. Experimental results on material behavior allows for calibration of mathematical material models, then implementation into the structural model and finally the analysis of the structure.

For this research, the following research questions are considered:

- (1) What is the range of deformation rates that the material could experience due to fire-induced thermal stress and explosion? What are temperatures at which these effects could be observed in fire?
- (2) How do the parameters of the structural steel change with respect to both the temperature and the high strain rates? How to effectively test material parameters? What is the sensitivity of material parameters to high temperatures and strain rates?
- (3) What constitutive model could be used to describe the observed behavior of the material?
- (4) What is the real influence of the fire-induced dynamic actions on the structure? To which extend these could be treated as quasi-static actions and when the dynamic effects shall be included explicitly in the model? Which kind of an analysis should be performed?

As can be seen from the defined research questions, there is a strong potential to expand the fundamental understanding of the behavior of structures exposed to combined thermal loading and high strain rates. This knowledge will facilitate the development of models and principles for the design of structures exposed to the combination of thermal and dynamic accidental actions.

It is postulated that steel structures exposed to fire and fire-induced dynamic actions can be successfully analyzed, capturing the physics related to the simultaneous effects of temperature and high strain rates. The general research plan is divided into four work packages (WP). The work packages consist of: (1) characterization of the fire and fire-induced dynamic loading; (2) preparation of experimental work; (3) conducting experiments; (4) modeling of materials and validation of structural elements. The research methodology is shown in Fig.1, where mutual relationships between work packages is presented.

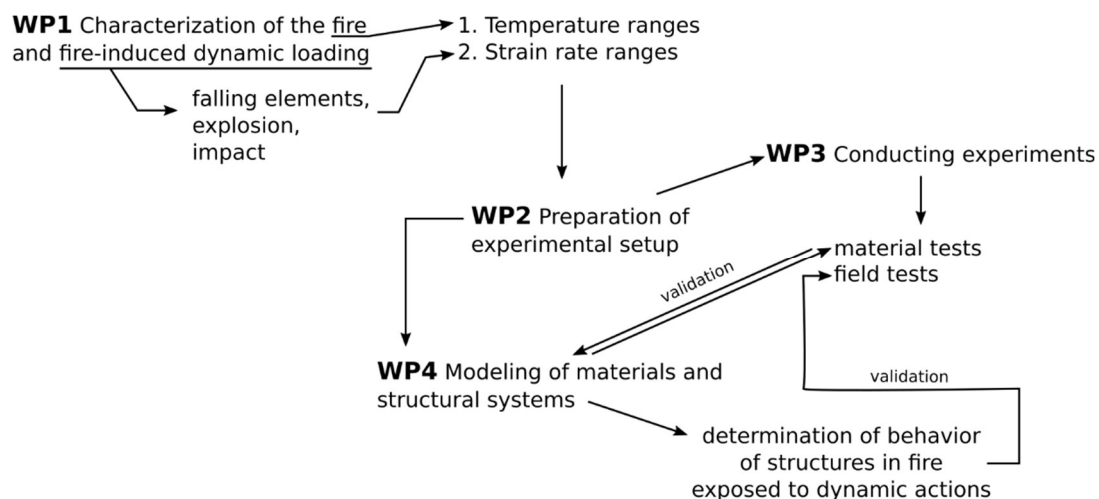


Fig.1 Research methodology with the relation to work packages.

Within the scope of the project, the following possible fields of innovations are recognized: new test methods for steel at high temperature and high strain rate, generalizing methodology for modeling of steel at simultaneous high temperature and high strain rates, development in modeling of structures in fire subjected to fire-induced dynamic loadings.